

CLAIMS

What is claimed is:

1. Method of forming different gate oxides on a semiconductor substrate, the substrate having a top surface, a first area and second area which is distinct from the first area, comprising:
 - forming a first gate oxide on the top surface of the substrate;
 - depositing a first layer of polysilicon over the first gate oxide;
 - forming a hard mask on top of the first layer of polysilicon;
 - forming a soft mask covering the first gate oxide, first layer of polysilicon and hard mask in the first area of the substrate;
 - removing the hard mask, the first layer of polysilicon and the first gate oxide in the second area of the substrate, leaving the second area exposed;
 - stripping the soft mask;
 - cleaning the exposed second area of the substrate;
 - growing a second gate oxide on the top surface of the substrate in the second area; and
 - removing the hard mask.
2. Method, according to claim 1, further comprising:
 - depositing a second layer of polysilicon over the second gate oxide.
3. A method, according to claim 1, wherein:
 - the first dielectric comprises a material selected from the group consisting of silicon dioxide (SiO₂), silicon oxynitride (SiON), silicon nitride (SiN) and high-k material.
4. A method, according to claim 1, wherein:
 - the first dielectric has a thickness of approximately 5 - 25 Angstroms.

5. A method, according to claim 1, wherein:
the first layer of polysilicon a thickness of approximately 20-500 Angstroms.
6. A method, according to claim 1, wherein:
the hard mask comprises a material selected from the group consisting germanium (Ge), silicon germanium (SiGe), amorphous carbon, SiO₂, Si₃N₄, and other materials that are easy to remove from a silicon wafer without leaving a residue.
7. A method, according to claim 1, wherein:
the hard mask has a thickness of approximately 300-500 Angstroms.
8. A method, according to claim 1, further comprising:
choosing an initial thickness for the hard mask to ensure that after stripping the soft mask, a thickness of greater than approximately 15 Angstroms of hard mask material remains in place on the substrate.
9. A method, according to claim 1, wherein:
the second gate oxide comprises a material selected from the group consisting of silicon dioxide (SiO₂), silicon oxynitride (SiON), silicon nitride (SiN) and high-k material.
10. A method, according to claim 1, wherein:
the second gate oxide is grown by a process selected from the group consisting of:
rapid thermal oxidation (RTO) in NO, N₂O, NH₃, O₂ (500-1100 degrees C);
plasma nitridation treatment on base oxide (25 - 800 degrees C);
plasma oxidation; UV oxidation; and atomic layer deposition.

11. A method, according to claim 1, wherein:
during growing the step of growing the second gate oxide, a portion of the hard mask becomes oxidized; and
further comprising:
removing the oxidized portion of the hard mask using an etch that will remove the oxidized portion of the hard mask without affecting the second gate oxide.
12. A method, according to claim 1, wherein:
the first gate oxide is thinner than the second gate oxide.
13. A method, according to claim 1, wherein:
the first gate oxide comprises a high-k material.
14. A method, according to claim 1, wherein:
the second gate oxide has a composition that is different than a composition of the first gate oxide.
15. Method of forming gate oxides on a semiconductor substrate, the substrate having a top surface, a first area and second area which is distinct from the first area, comprising:
forming a first gate oxide on the top surface of the substrate;
protecting the first gate oxide from damage during subsequent processing steps by forming a sacrificial hard mask over a selected area of the first gate oxide; and
then forming a second gate oxide.
16. A method, according to claim 15, further comprising:
before forming the sacrificial hard mask, depositing a first layer of polysilicon over the first gate oxide.

17. A method, according to claim 15, further comprising:
then removing the sacrificial hard mask.
18. A method, according to claim 17, further comprising:
after removing the sacrificial hard mask, depositing a second layer of polysilicon over the second gate oxide.
19. A method, according to claim 18, further comprising:
before forming the sacrificial hard mask, depositing a first layer of polysilicon over the first gate oxide;
wherein:
the second layer of polysilicon extends over the first layer of polysilicon.
20. Method of forming at least two different gate dielectrics on a substrate, the substrate having a surface comprising first areas and second areas, the method comprising:
forming a first gate dielectric on the surface of the substrate;
forming a first gate electrode on the first gate dielectric;
forming a sacrificial hard mask on the first gate electrode in the first areas of the substrate;
removing the first gate electrode and the first gate dielectric in the second areas of the substrate;
cleaning and oxidizing the second areas of the substrate to form a second gate dielectric;
removing the sacrificial mask selective to the second gate dielectric; and
depositing a second gate electrode electrically connected to the first gate electrode.